

PRELIMINARY EVALUATION AND SITING STUDIES FOR POTENTIAL GEOLOGIC STORAGE OF CARBON DIOXIDE IN ARIZONA

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Potential Confining Bed, Chinle Formation Near Chinle, Arizona

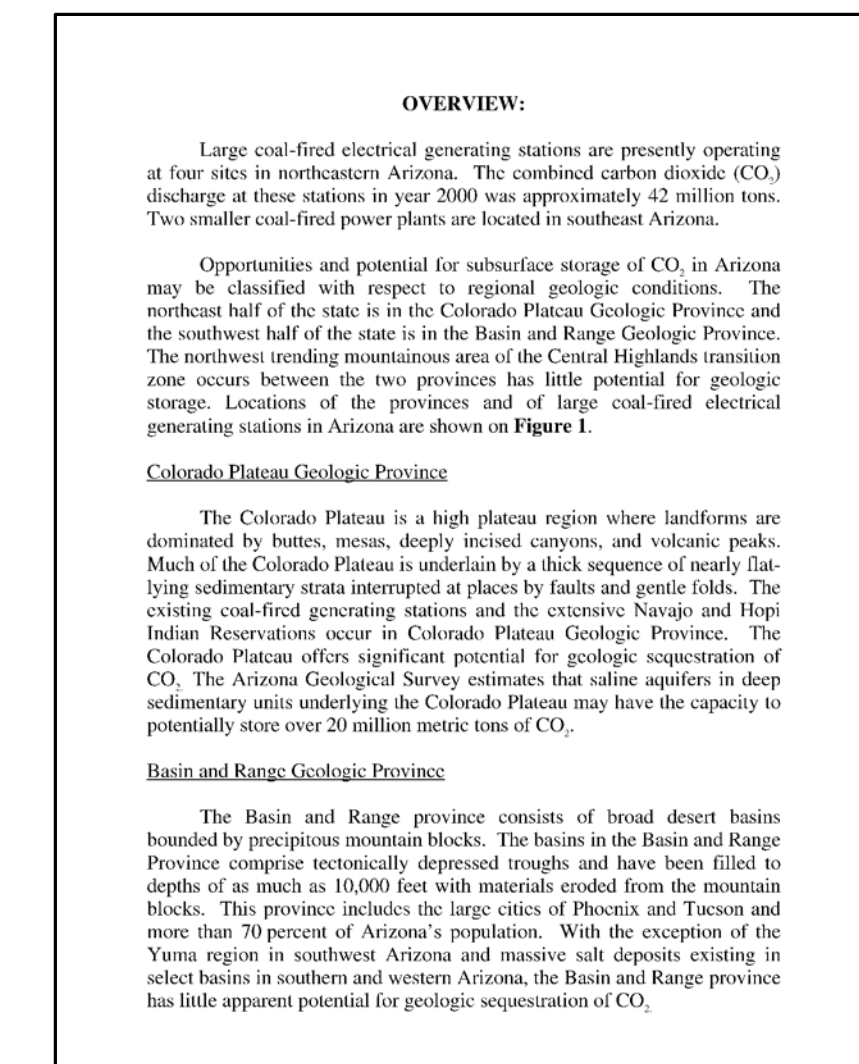
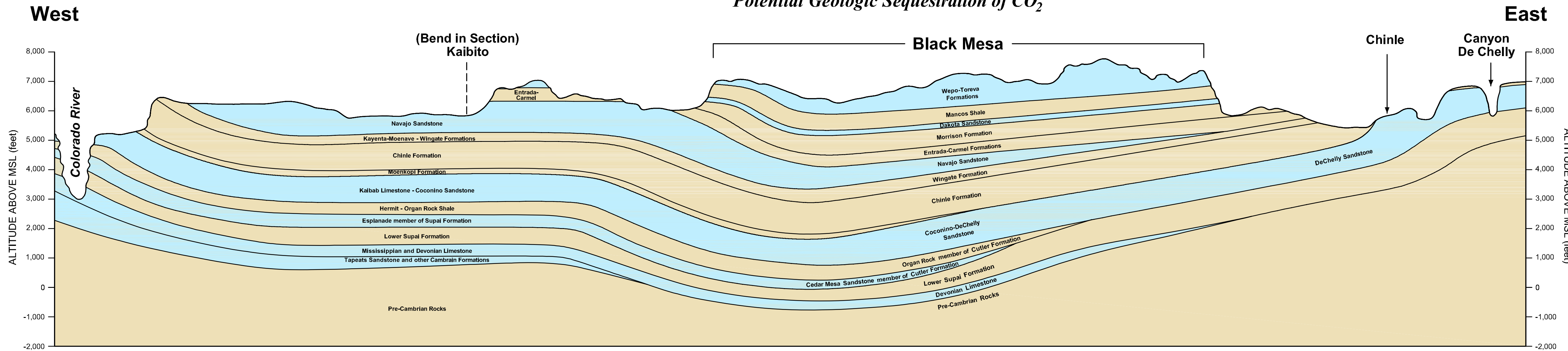


Figure 1. Colorado Plateau Regional Study

Geologic Unit	Age	Thickness (feet)	Description	Remarks
Campanian	Jurassic	65-200	Claystone and sandstone	Confining bed beneath Black Mesa
Navajo SS.	Triassic & Permian	100-1,000	Fine to medium-grained calcareous sandstone; porous 25-50%	Potential reservoir beneath Black Mesa but groundwater contains >1,000 TDS
Egyptian, Navajo, Moenkopi	Triassic	650-820	Mudstone, siltstone, and sandstone	Primarily serve as confining beds in S. Black Mesa area
Chinle Formation	Triassic	300-1,300	Primarily heterolithic; argillaceous, some sandstone and conglomerate	Excellent confining unit in much of NE Arizona
Moenkopi Formation	Triassic	100-300	Siltstone and sandstone	Not considered an effective confining unit
Coconino / DeChelly Sandstone	Permian	320-1,000	Fine to thick, graded calcareous sandstone	A major potential reservoir in much of NE Arizona; groundwater contains <100 TDS in 5,000 feet of eastern Black Mesa area
Hermat Shale / Organ Rock	Permian	100-130	Primarily siltstone with sandstone lenses	Confining unit in Grand Canyon-Black Mesa area
Esplanade / Lower Supai	Permian	65-650	Permian sandstone with siltstone facies	Potential reservoir; not present in SE part of area shown on Figure 2 and 3
Lower Supai / Lower Permian	Permian	330-380	Siltstone, sandstone, and limestone; contains salt beds in SE Black Mesa area	Acts as both confining unit and potential CO ₂ reservoir
Redwall Limestone, Temple Butte Limestone, and Martin Formation	Mississippian & Devonian	300-1,000	Primarily limestones and dolomites; cavernous in Grand Canyon area	Potential reservoir; not present in SE part of area shown on Figure 2 and 3
Tukey Sandstone	Cambrian	105-400	Folitic, micaceous sandstone	Potential CO ₂ reservoir

Table 1. Geologic Reservoirs and Seals in Colorado Plateau Province, Arizona



Geologic Cross-Section from Colorado River, Through Black Mesa, to Canyon de Chelly

SITE SELECTION FOR ARIZONA DEMONSTRATION PROJECT

Based on the screening and evaluation of potential CO₂ storage sites in the Colorado Plateau region of northeast Arizona and consideration of WESTCARB project objectives, the Cholla Area (see Figure 2) was prioritized for potential consideration for the Arizona demonstration project. Two important factors were pivotal in selecting the Cholla Area for further consideration. First, the Cholla Area is the most favorable area in the Colorado Plateau under consideration in lands outside of the Navajo Nation and Hopi Indian reservation. Oil and gas test wells drilled in this area indicate that most of the Cholla Area appears favorable for geologic carbon dioxide storage, whereas areas to the east in the vicinity of the Salt River Project (SRP) Colorado Generating Station are less favorable. Efforts undertaken by SRP and WESTCARB to engage the Navajo Nation to participate in the Arizona demonstration project indicated timely implementation of the pilot project on lands of the Navajo or Hopi Indian Tribes would be problematic.

A second key factor supporting pilot project implementation in the Cholla Area was based on water quality of the regional aquifer in the Coconino/DeChelly Sandstone. As shown in Figure 3, groundwater wells penetrating the regional aquifer indicate an extensive area of poor quality groundwater exists just north of and roughly parallel to the Little Colorado River in this region. Total dissolved solids in groundwater range from approximately 20,000 to 70,000 milligrams per liter in this area due to the presence of evaporative salts in the underlying Supai Formation. Although there is little data to interpret water quality of deeper groundwater systems, the highly saline conditions present in the uppermost aquifer in the northern Cholla Area give reason to believe that underlying groundwater in potential CO₂ reservoirs will be saline.

Most of the Cholla Area appears favorable for supercritical carbon dioxide storage but this discussion will focus on two sites shown on Figure 4. Site One is in the northeast part of Arizona Public Service (APS) property at the Cholla Power Plant. Site Two is about 15 miles northwest of the Cholla plant, near State Route 87, just south of the Navajo Reservation boundary, in T20N, R18E, near the Ives Mesa Dome. The sedimentary section is about 5,000 feet thick at proposed Site Two, and ranges in age from Cambrian through Triassic. At Site One, near the Cholla Plant, the sedimentary section is only about 3,800 feet thick, due to the absence of the

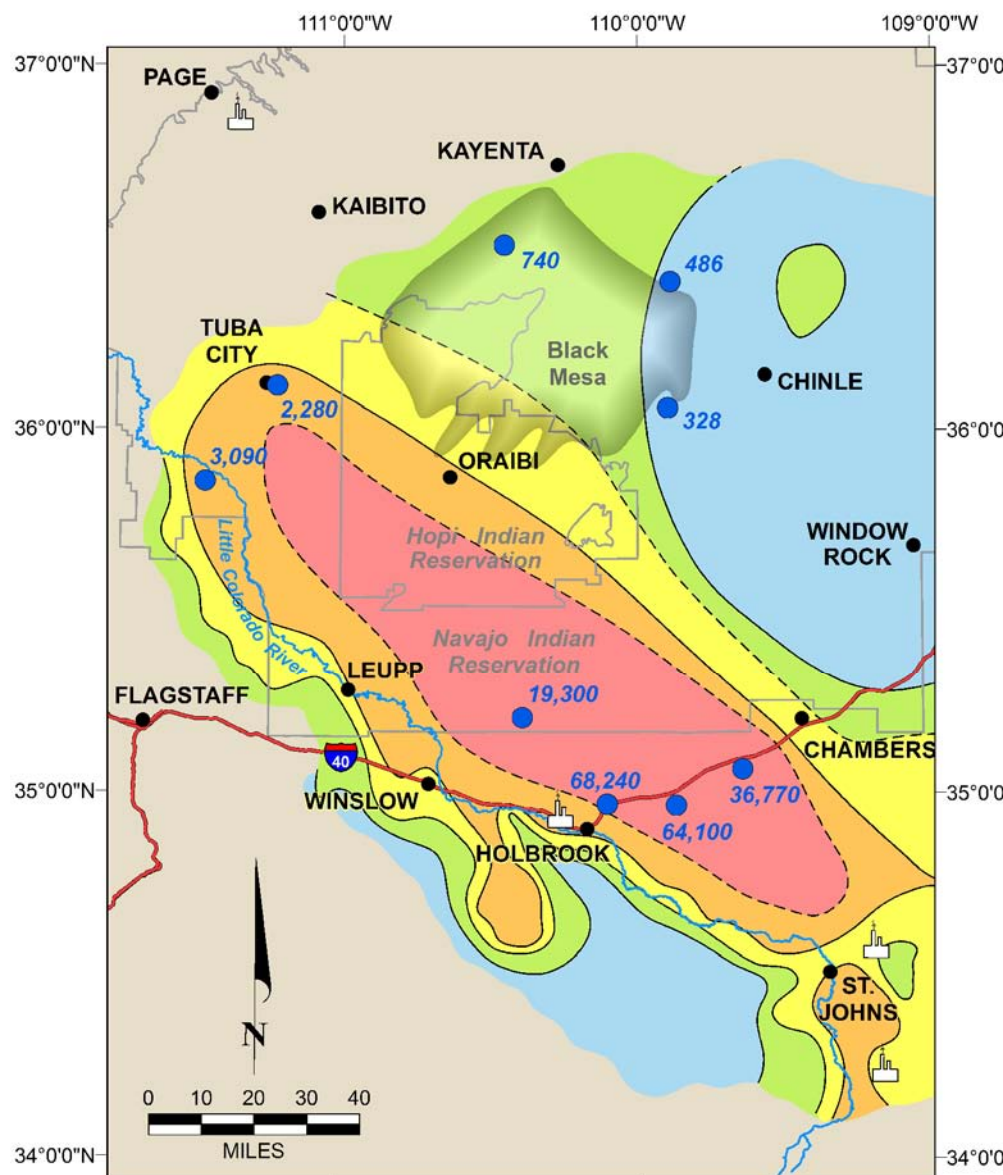


Figure 3. Distribution of TDS in Coconino / DeChelly Sandstone

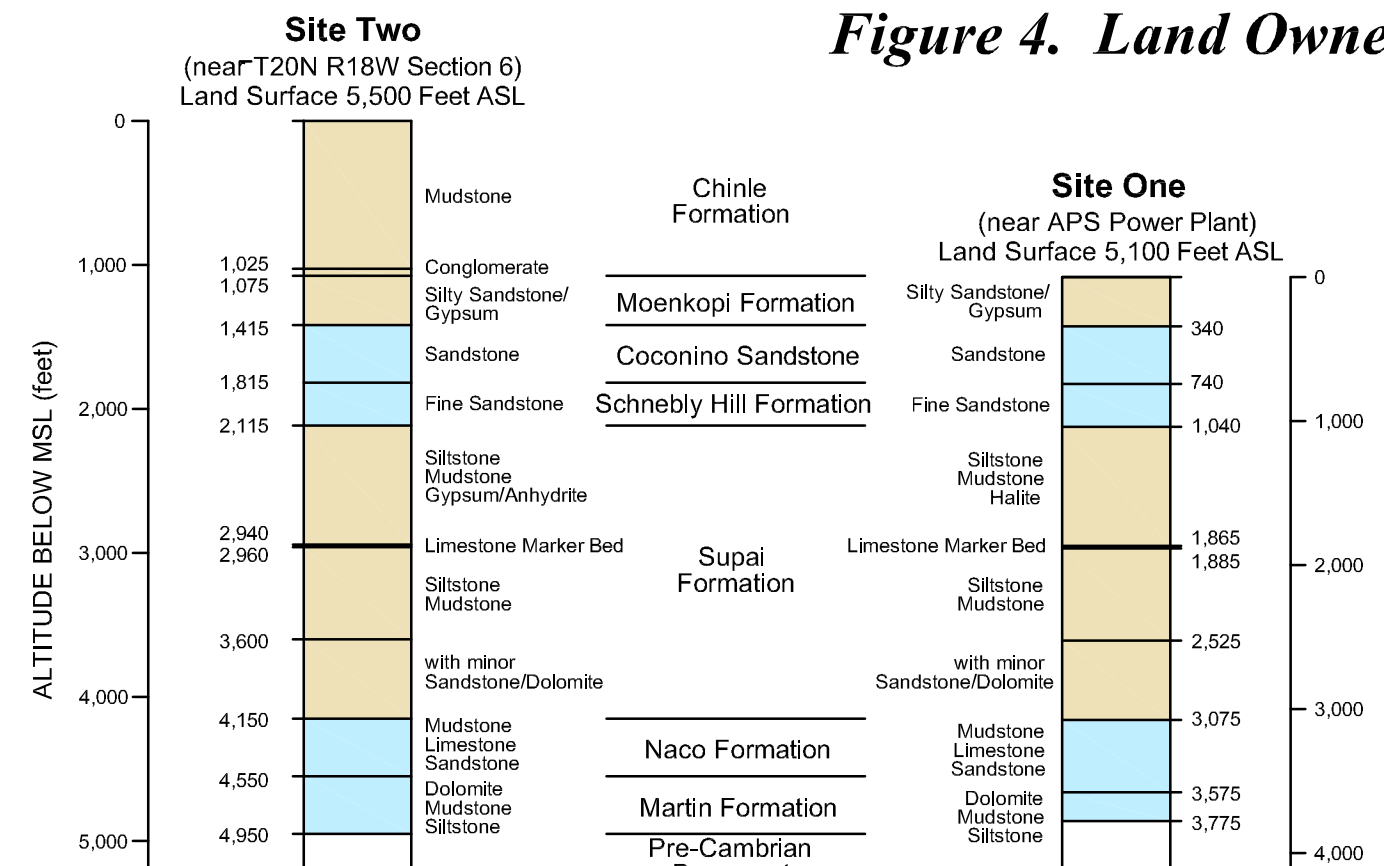


Figure 4. Land Ownership in Cholla Area

TRIASIC CHINLE FORMATION. Target storage reservoirs throughout the Cholla Area would be the Pennsylvanian Navajo Formation and the Devonian Martin Formation (primary targets). Inferred geology at these sites is shown in Figure 5.

Discussion of Proposed Demonstration Sites One and Two

Site One would be located on APS property in the vicinity of the Cholla power plant. This site offers the principal advantage of ease of implementation in terms of arranging access and permission to conduct the drilling of pilot well and installation of injection test. In addition, review of geological logs indicates that the primary target reservoir, the Martin Formation may be sandier (more porous and permeable) at Site One, because it is nearer the Devonian depositional shoreline.

Site Two would be located in T20N, R18E, perhaps in Section 2, 4, 8, or 10, which are all state-owned sections. The site would be east of State Route 87 and south of the Navajo Reservation. This site is suggested because it offers: (1) relatively thick sections of Martin and Navajo Formations, (2) hydrostatic heads would be relatively large, (3) access to near the site on paved roads, (4) presence of state-owned land, (5) no artificial structures and, (6) it is relatively distant from communities.

In summary, Site One near the APS power plant has the potential advantage of fewer injection site ownership and permitting problems, and the disadvantage of lesser depths to potential storage reservoirs, and smaller reservoir thickness. Site Two, 15 miles northwest of the power plant, has the advantage of larger reservoir depths and thicknesses. For both sites, paved access is available to lands that might be considered for an injection site. From a technical standpoint, Site Two, near the Ives Mesa Dome, is the superior location for a pilot injection test.



Figure 5. Inferred Geology in Cholla Area